

Impact Based Warning System and Decision Support Activities for Winter Weather at NOAA/NWS Marquette, MI

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NOAA/NWS Marquette, MI

**Great Lakes Operational Meteorology
Workshop**

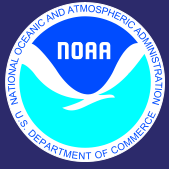
2013 May 07



Outline

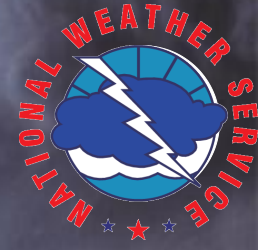


- **Overview of the NWS MQT Impact Based Warning System**
 - *Background*
 - *Methodology*
 - *Results*
- **Some Decision Support Activities for Winter Weather at NWS Marquette**



Impact Based Winter Warning System at NWS MQT





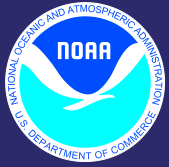
Introduction

- **National Weather Service Mission Statement**
 - *" The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community. "*
- **The people of Upper Michigan need winter weather information that depict accurate hazards for the area. With or without headlines, winter weather affects:**
 - **Safety**
 - **Commerce**
- **"Help me help you" - Our understanding of our customer winter weather impacts further helps us help the community mitigate winter weather impacts**



Background

- In the past, all of our winter statements focused purely on the meteorology (snow/ice accumulation, etc.).
- We had little idea of what impacts really occurred during winter weather and whether our winter weather advisory/warning criteria was adequate.



Background

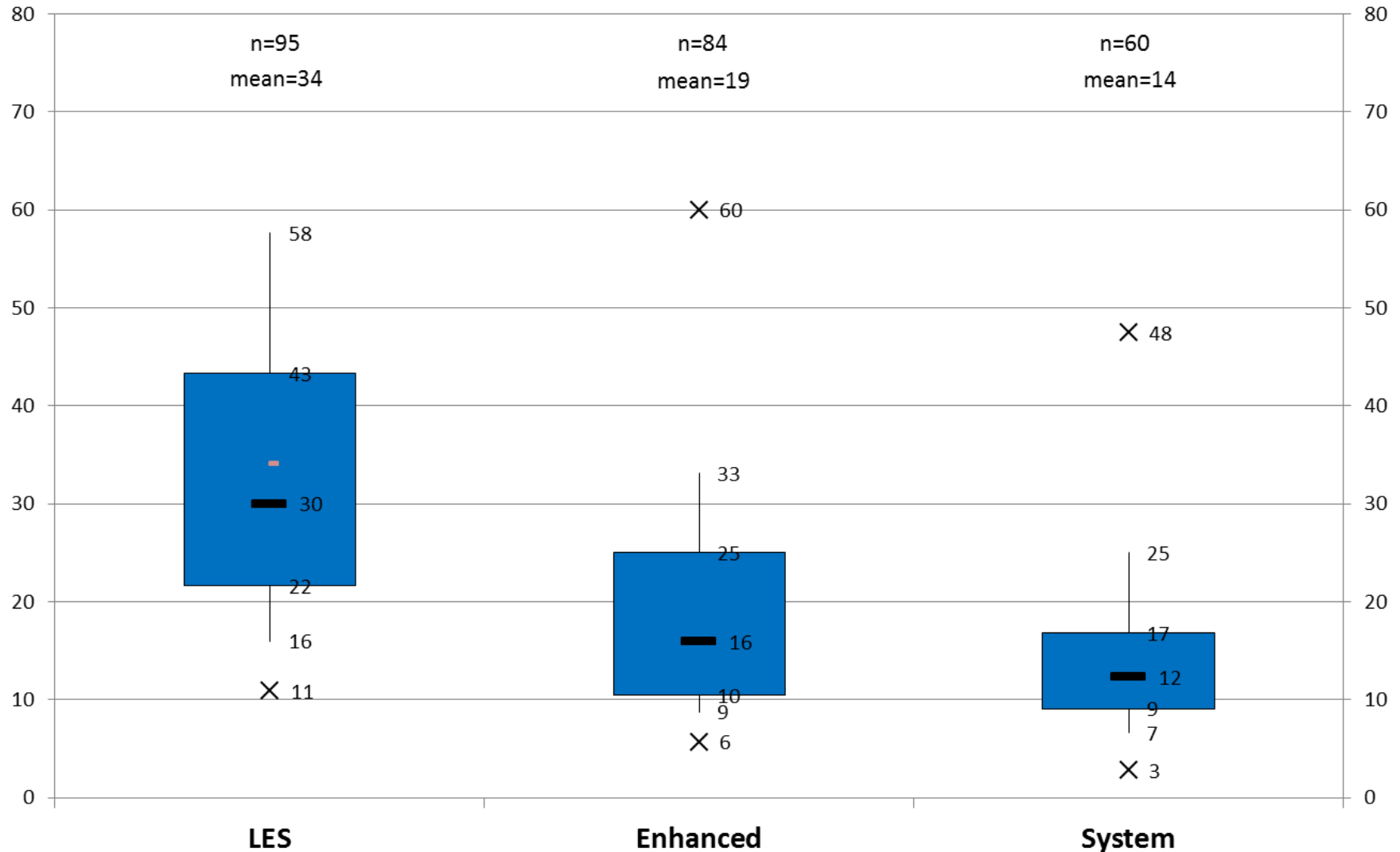
- Upper Michigan receives all “types” of snowfall with significant differences in SLR values
 - *Lake Effect Snow*
 - *System Snow*
 - *Lake Enhanced Snow*
- Forecasters had a sense that different types of snow related to different impacts, but it was unclear of what those were.



Snow to Liquid Ratios (SLR) for NWS Marquette for Lake Effect, Lake Enhanced and System Snowfalls at least 1in/6hr



Solid Bar -- Median Value; Boxes 25th-75th Percentile; Whiskers 10th/90th Percentile
(x - extreme values)

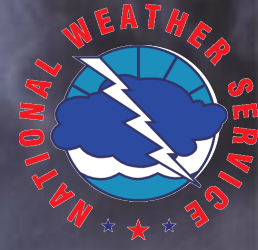




Objective



- **Better understand impacts related to Upper Michigan winter weather**
- **Refine winter weather headline issuance criteria and to account for community impacts**
- **Better communicate sociological and economic impacts in statements**

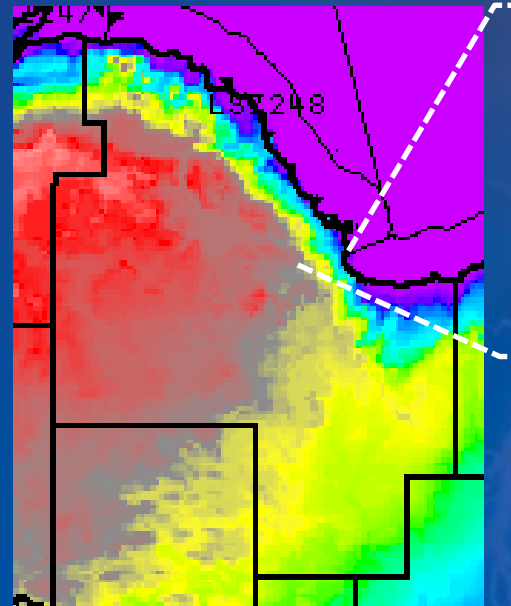


Methodology

- **Collect incident reports from 2007-2012 in Marquette County**
 - *Incident reports included Traffic Accidents/Incidents, Power Outages, Exposure*
- **Gathered meteorological data for same period:**
 - *WFO Marquette data included: Six hourly snowfall and Liquid Equivalent, Winds and Six hourly max/min temperatures*
 - *MCGM4 data included: Winds and Six hourly max/min temperatures*
- **Relate the meteorological data with incident reports**
- **Use the findings to possibly refine our winter hazard criteria and to place impact statements in our products**



- **WFO Marquette CWA features widely diverse microclimates**
 - *Higher Terrain vs. lakeshore vs. swamp*
 - 10-20°F difference between MCGM4 and WFO MQT common
 - *Lake effect snow accumulations vary extensively*
 - *Elevation differences*



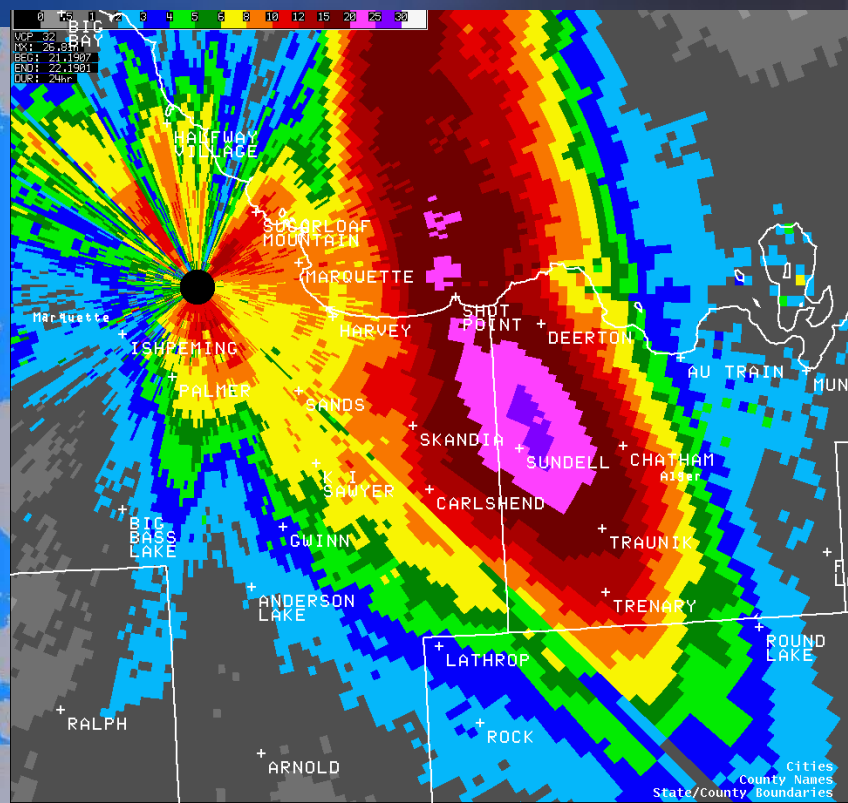
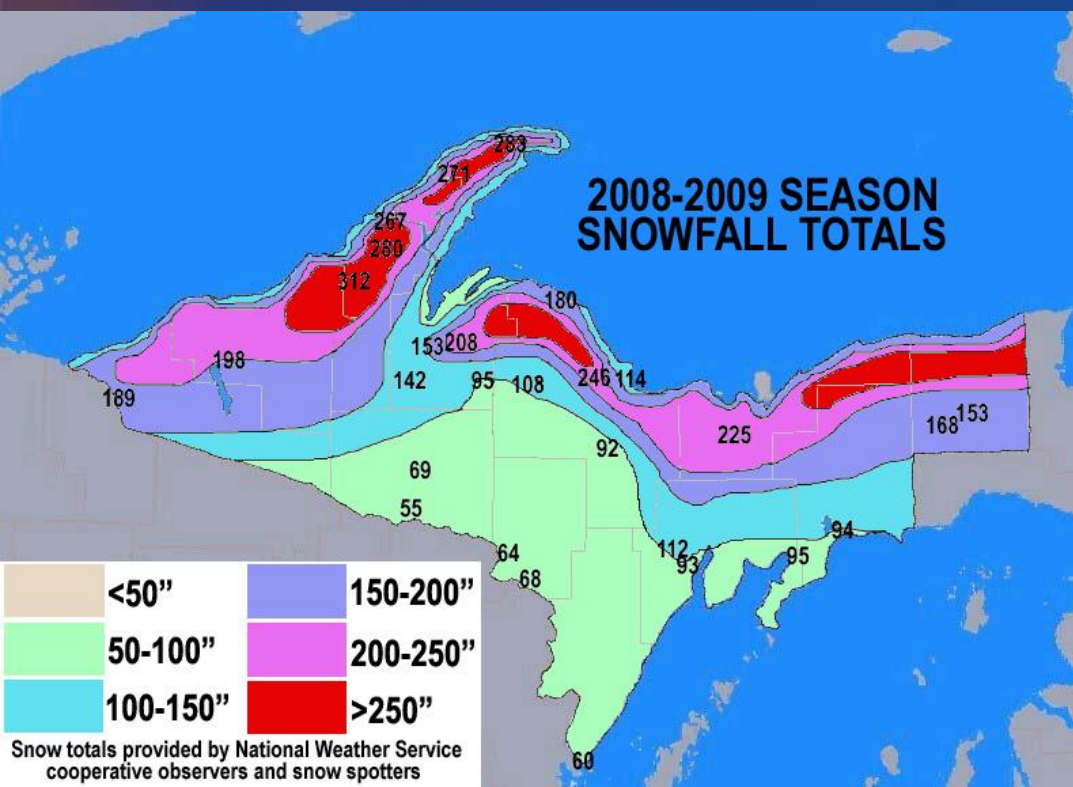
WFO MQT
Elev: ~1450ft

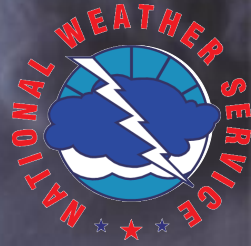


Challenges and Error



- Six hourly snowfall data resolution
 - *Spatial: Only available at WFO MQT*
 - *Temporal: Six hourly minimum*
 - Did 6 inches of snow fall in 2 hours or 6 hours?





Preliminary Results

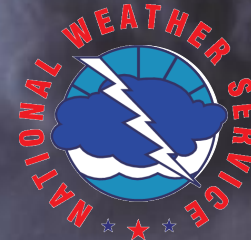
- In the latest round of this research, we compared traffic incidents to several contributing factors. These include:
 - *Snowfall Amounts*
 - *Time of Day*
 - *Day of Week*
 - *SLR*
 - *Wind Speeds*
 - *Temperature*



Number of Events (2007-2012)

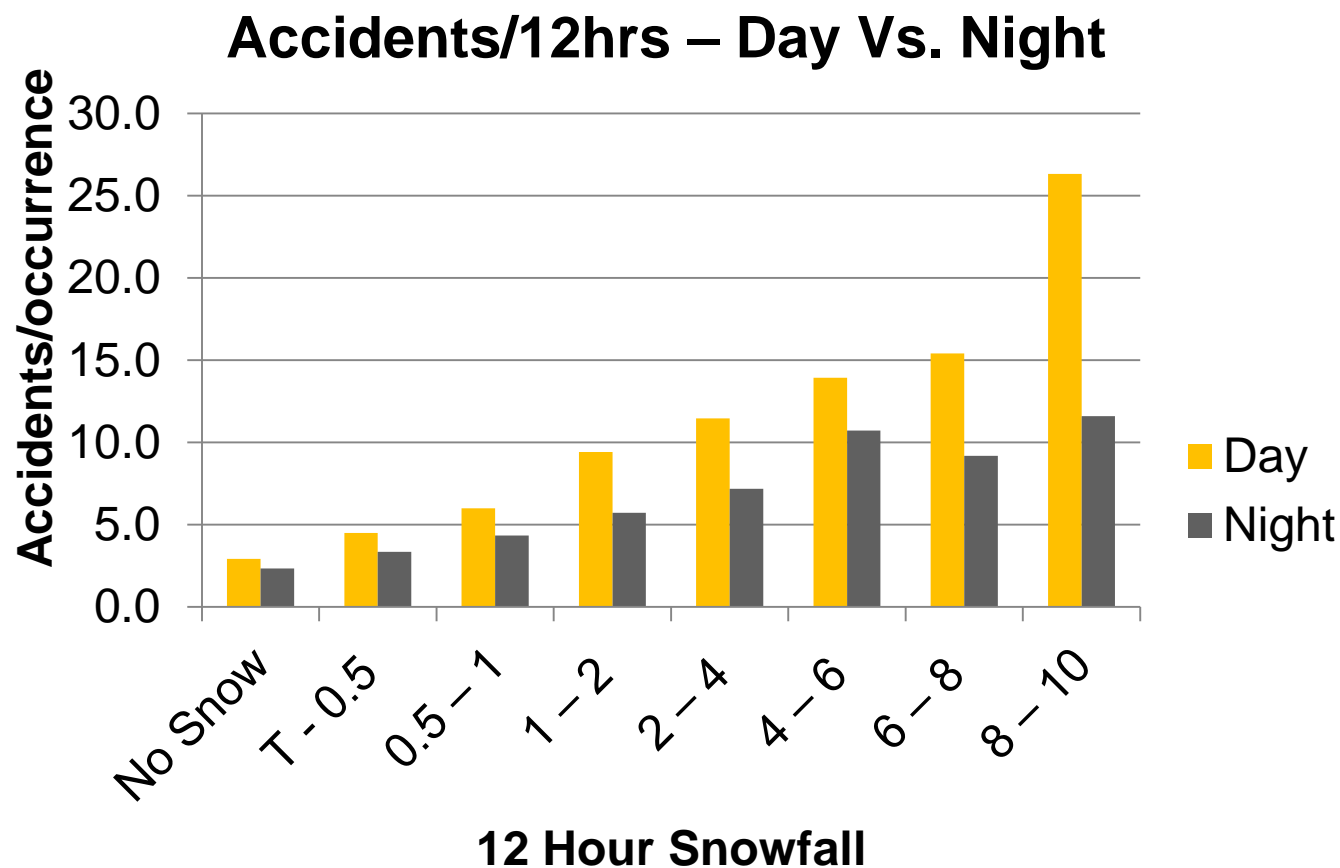


| Snowfall Range (in) | Number of events | Total Incidents |
|---------------------|------------------|-----------------|
| No Snow | 2079 | 5449 |
| T-0.5 | 1093 | 4379 |
| 0.5-1 | 230 | 1184 |
| 1-2 | 203 | 1528 |
| 2-4 | 160 | 1509 |
| 4-6 | 61 | 747 |
| 6-8 | 33 | 409 |
| 8-10 | 8 | 137 |
| ≥ 10 | 9 | 180 |



Day Vs. Night

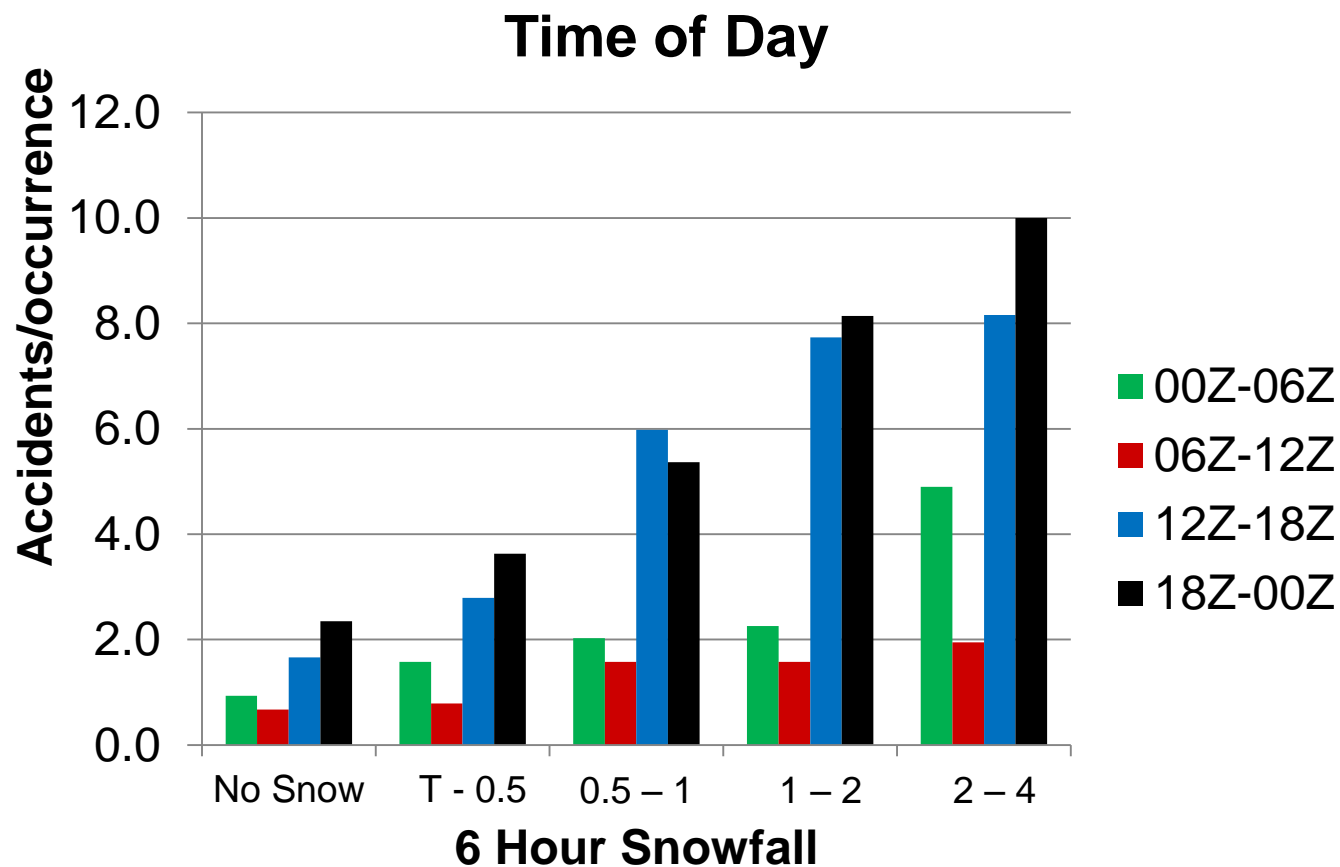
- Daytime periods had more incidents regardless of weather conditions





Time of Day

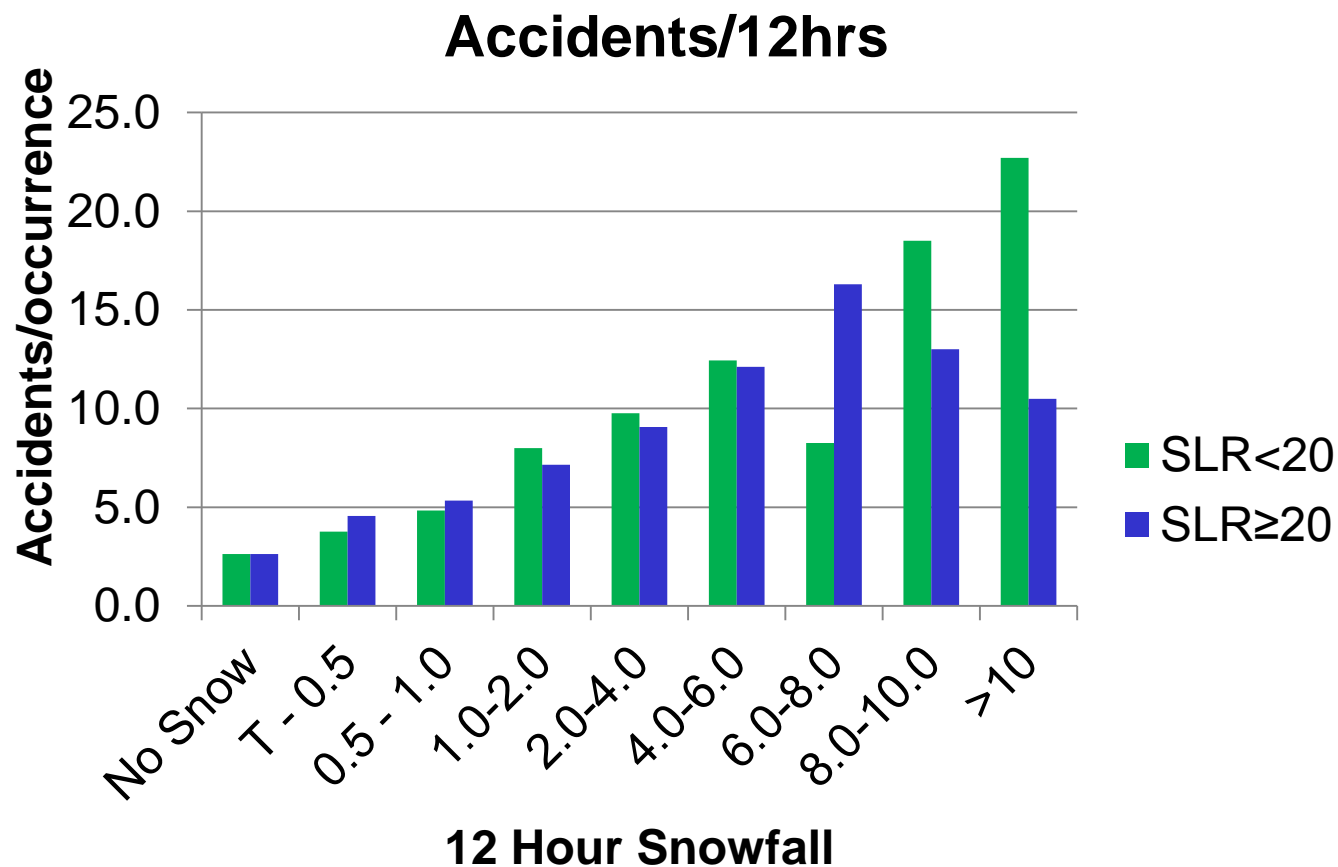
- Late afternoons and early evenings had more incidents regardless of weather conditions

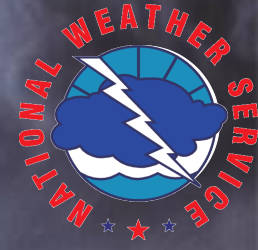




Low Vs. High SLR

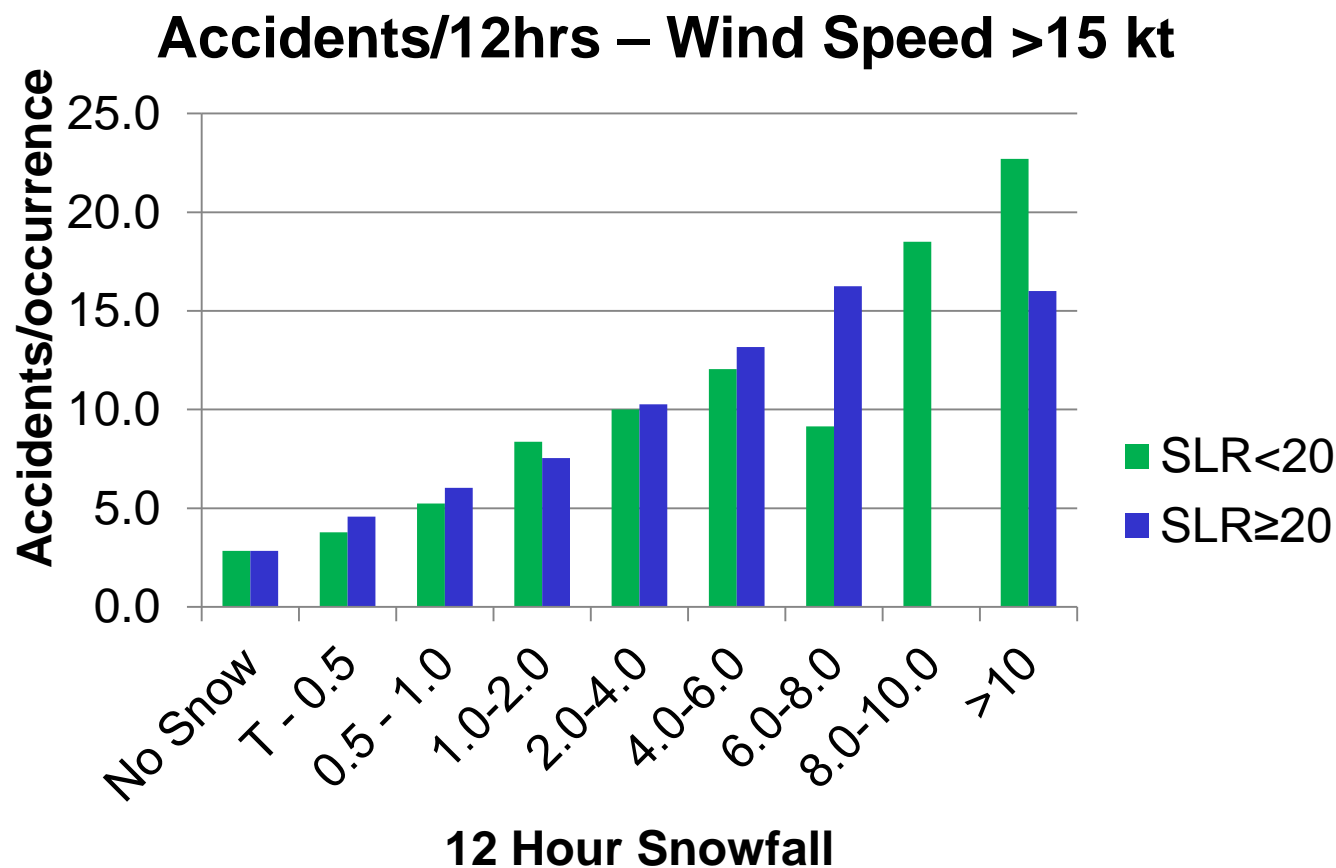
- Lower SLR values yielded higher incidents, especially values above 1 inch.





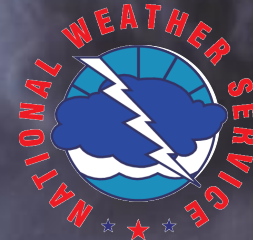
Low Vs. High SLR - Windy

- Max Wind speeds ≥ 15 kt counted
- High SLR combined with stronger winds generally yields more accidents
 - *Blowing snow reduces visibility with more drifting*

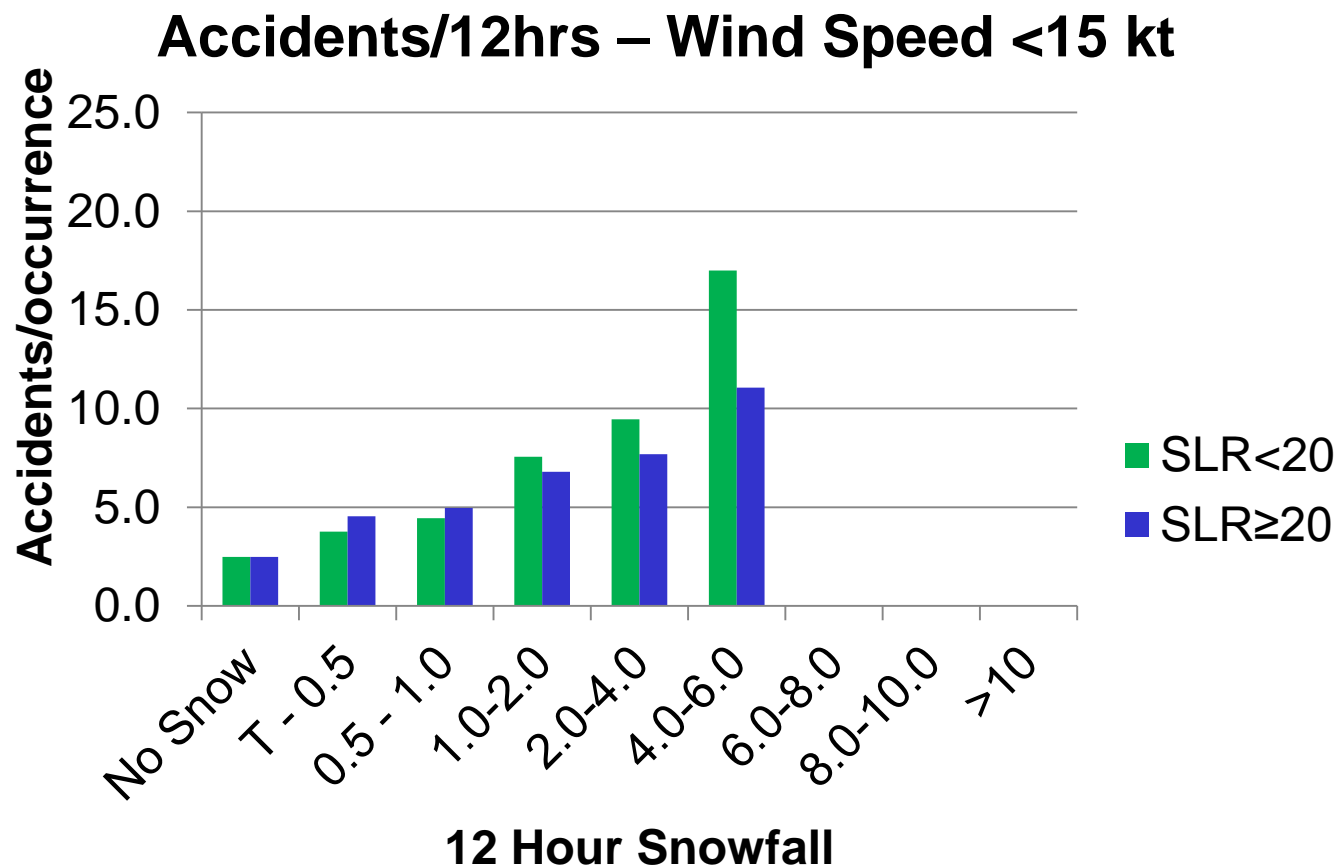




Low Vs. High SLR – Light Winds



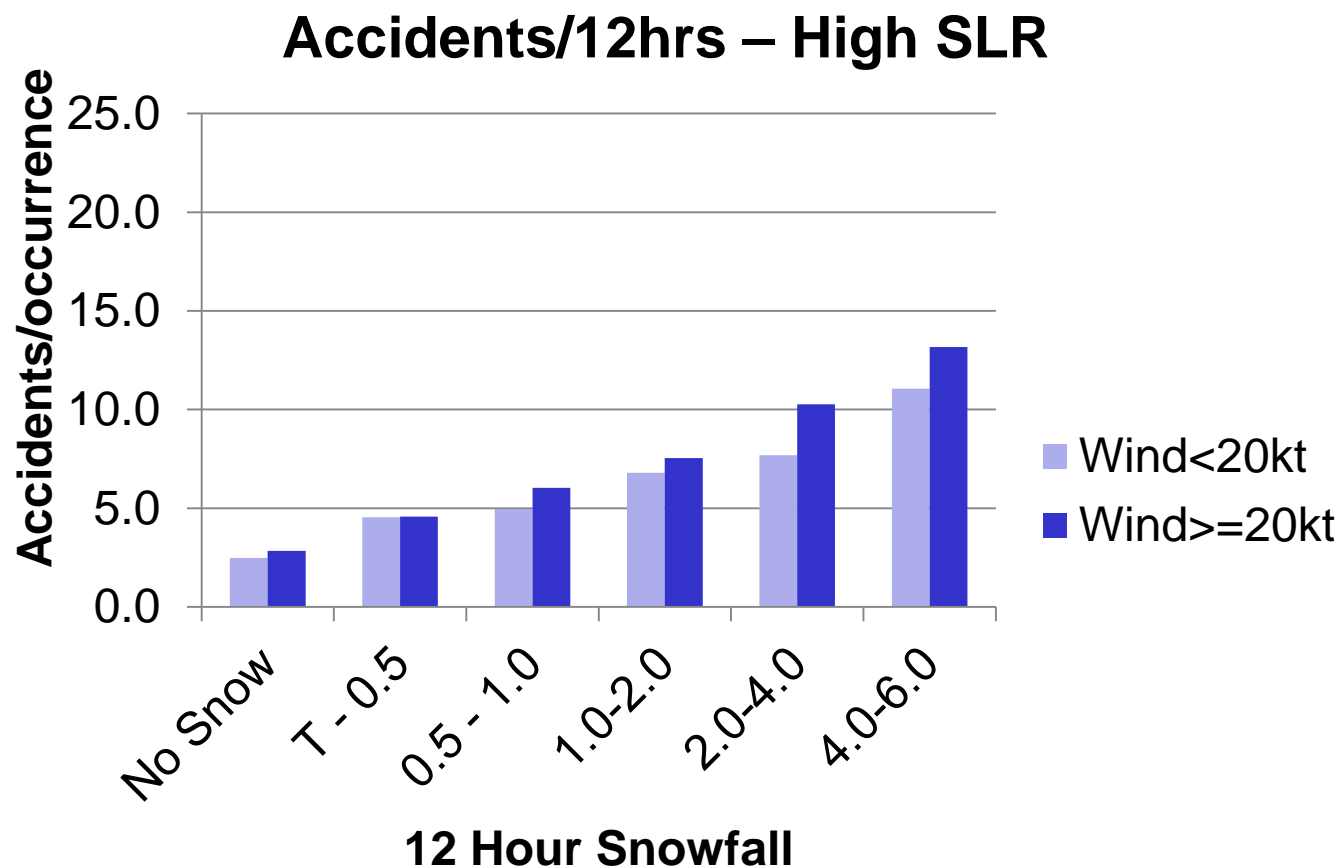
- Wind speeds <15 kt counted
- Lower SLR values create more accidents during light winds, especially with higher snowfalls.

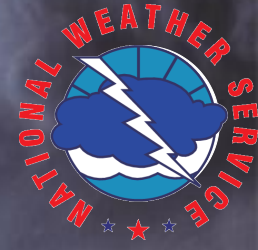




High SLR – Calm Vs. Windy

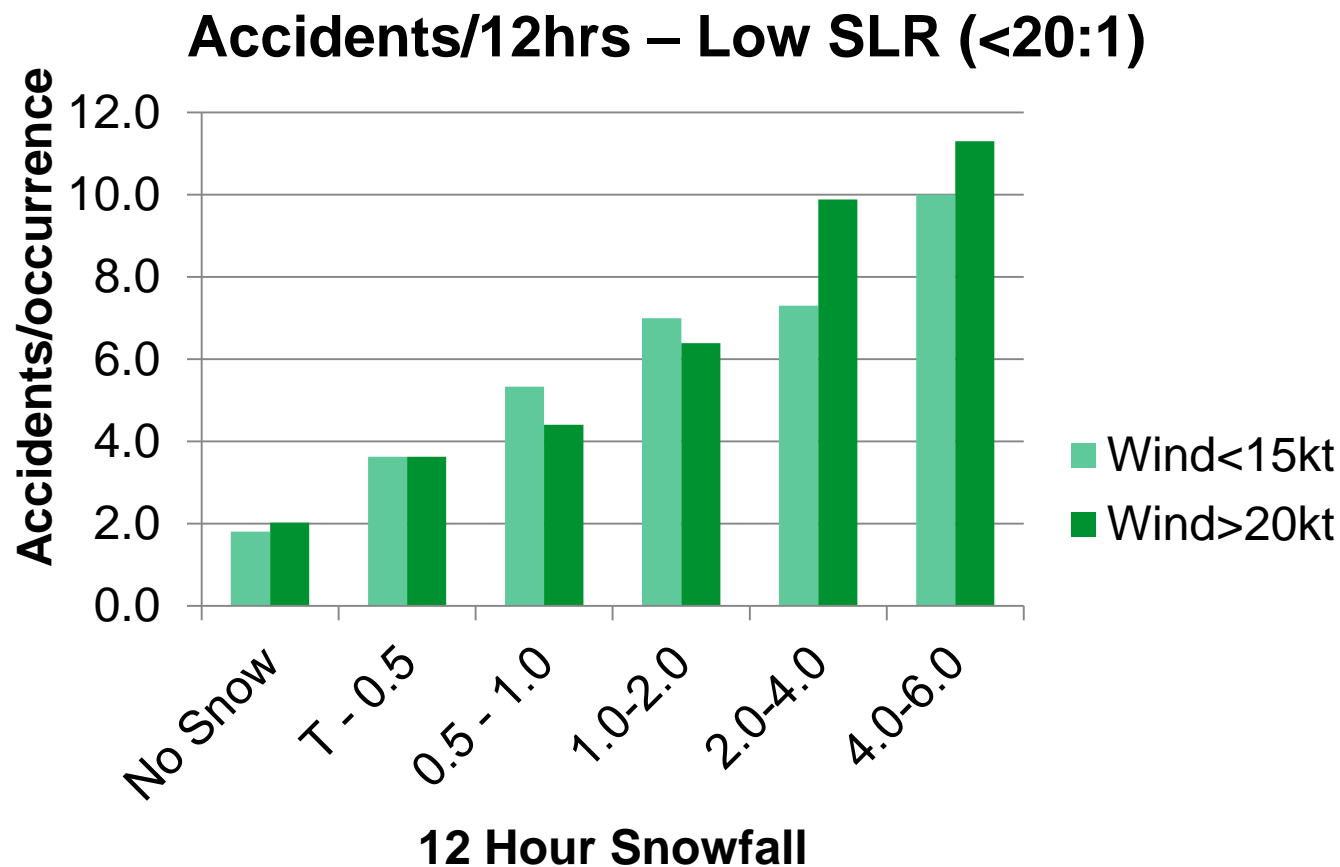
- High SLR snow worse in windy conditions than calm conditions

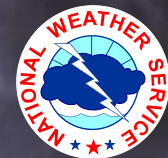




Low SLR – Calm Vs. Windy

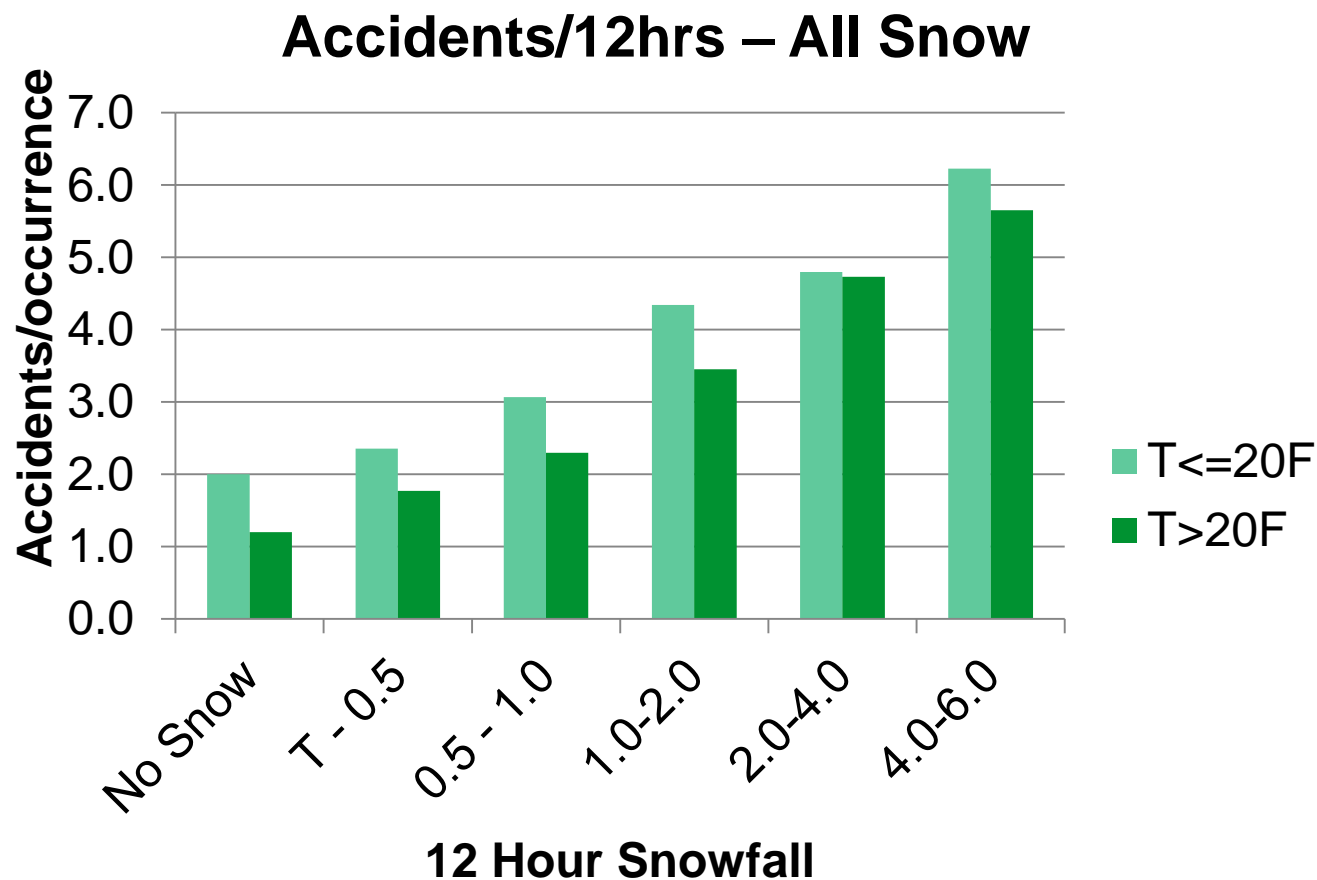
- Difference between windy and calm conditions more similar than with high SLR snow.
 - *Low SLR snow is less prone to blow around*





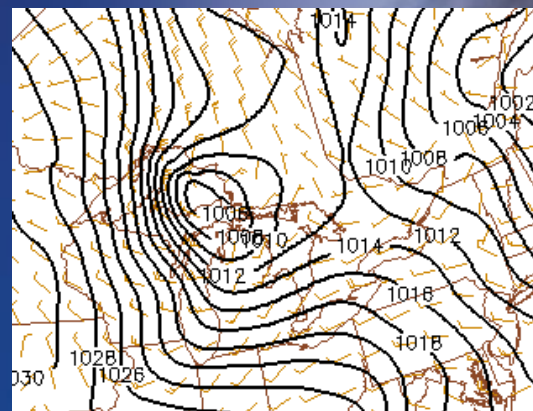
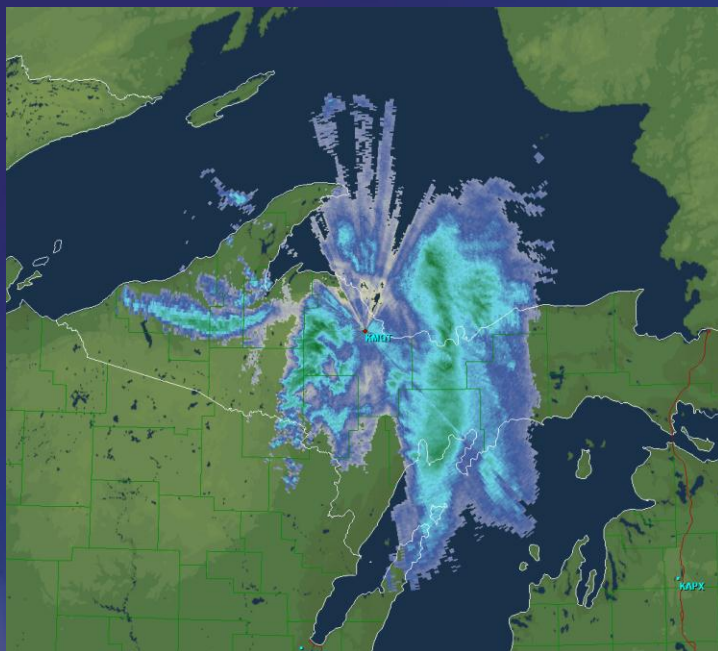
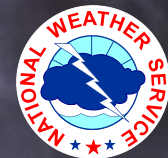
Snow vs. Temperature

Below 20F, road treatments are not as effective





27 Nov 2007



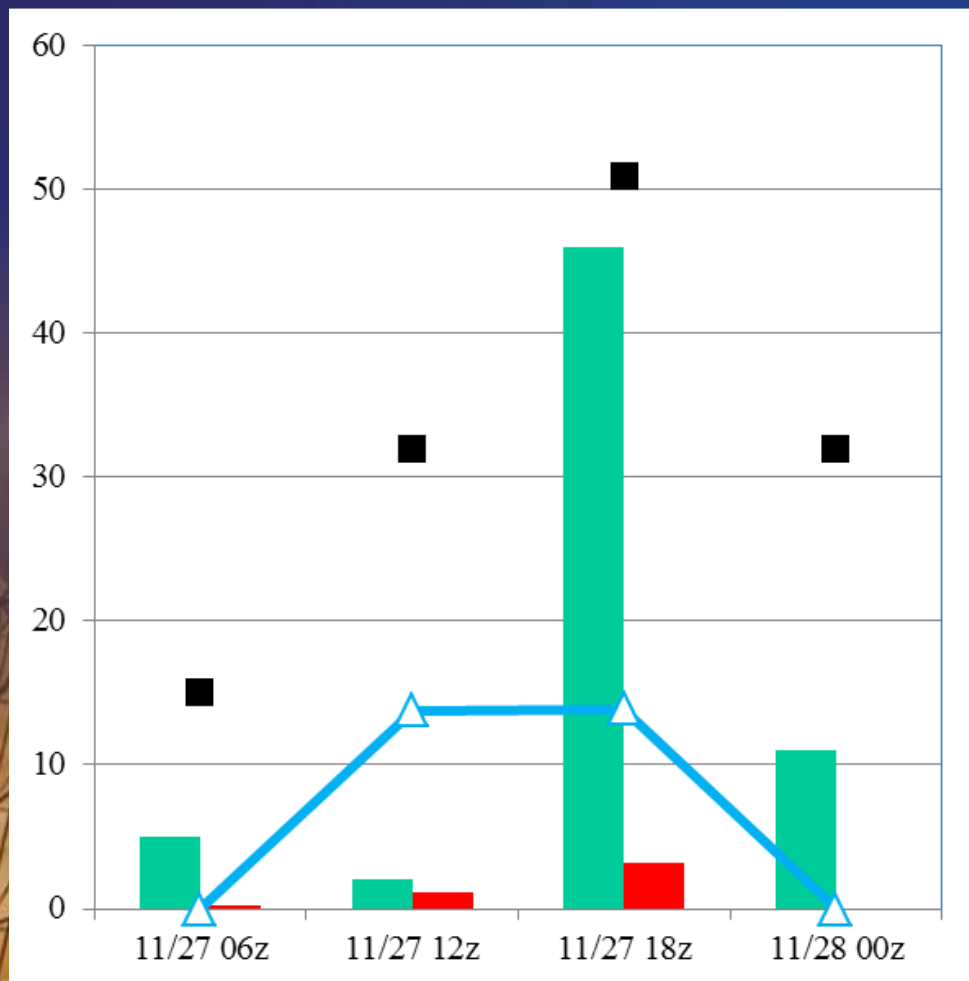
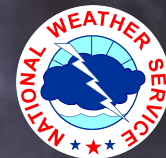
- **Very intense, but short lived storm. Nearly 50 incidents were reported during the height of the storm (around morning commute - Tuesday)**
- **Storm total snowfall = 4.5 in**
- **SLR ~13:1**
- **Very intense sustained winds > 35 mph**
- **Frequent vsby < 1/4sm**
- **Duration of the main event (snowfall rates 1-2 in/hr) only lasted 2 hours (not blizzard criteria).**



Courtesy: The Mining Journal

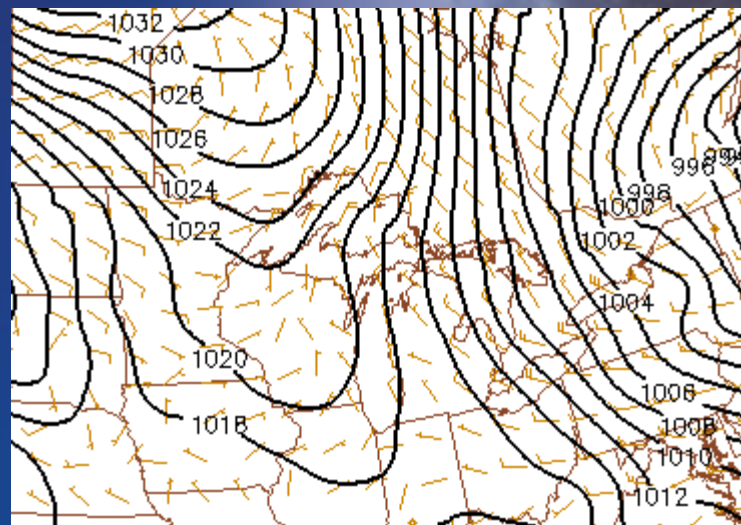
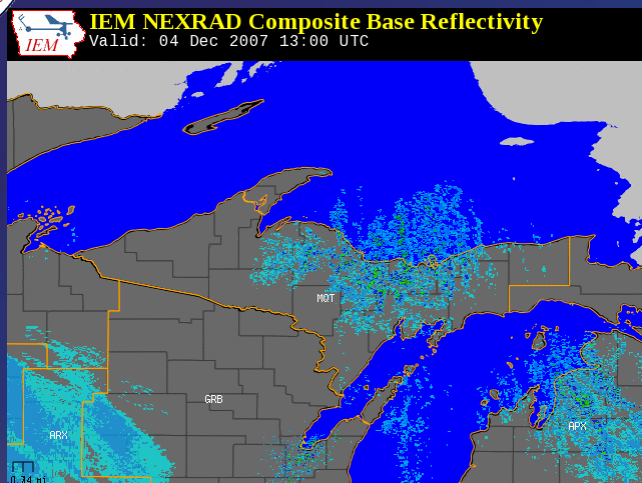
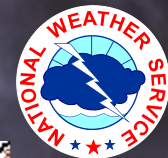


27 Nov 2007

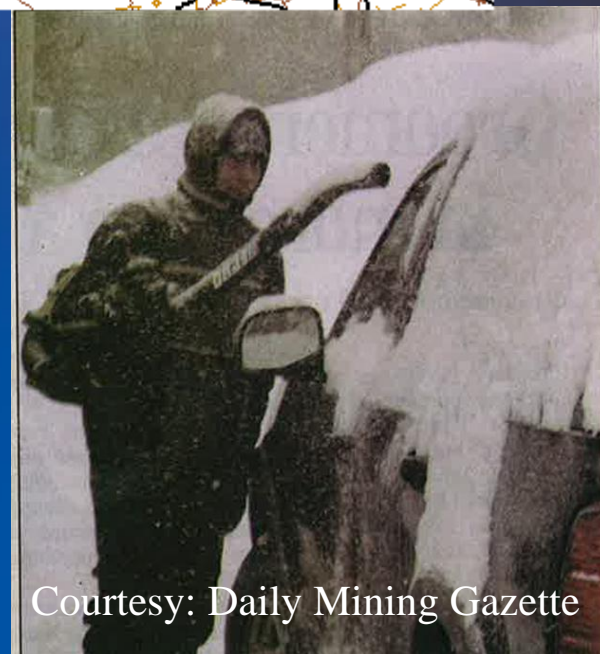




2007 Dec 4-5



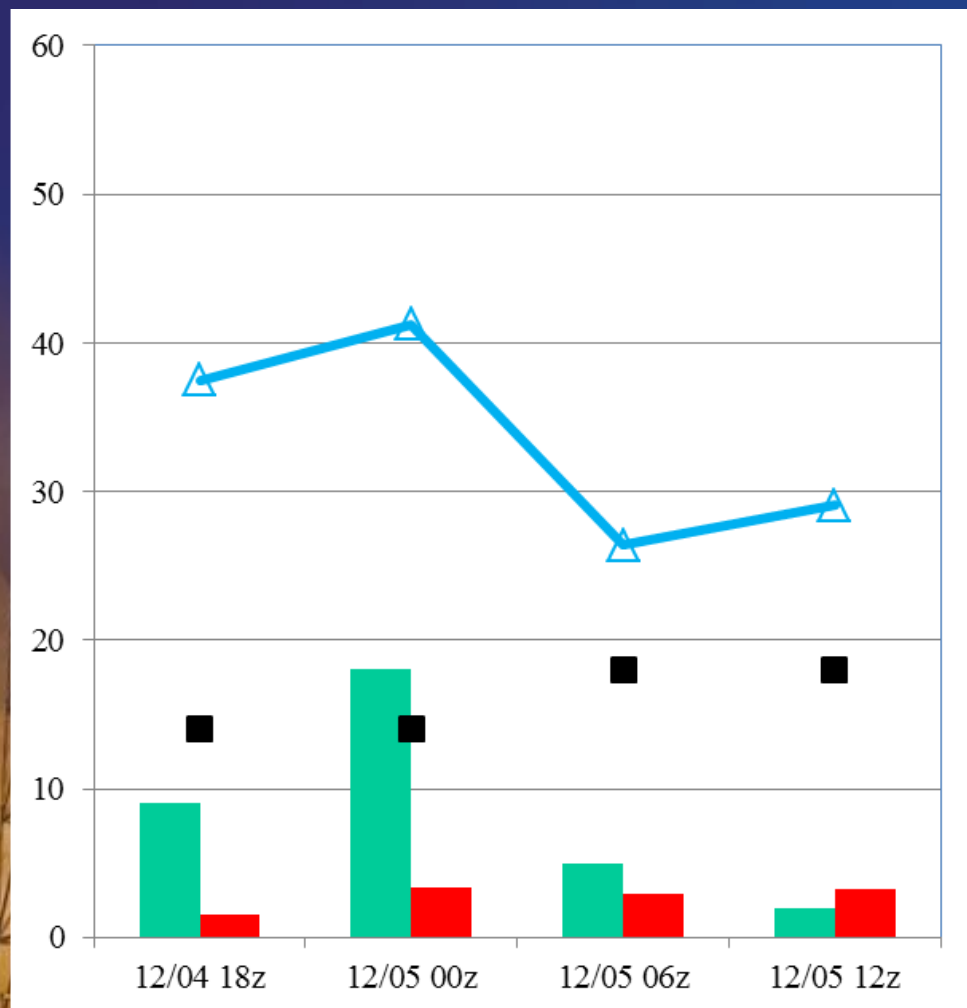
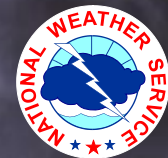
- **Classic long duration LES event – 10.3 in snowfall in 24hr (60hr snow of 2+ ft) during the week**
- **SLR ~ 32:1**
 - *Leaf Blower Snow*
- **Only 34 incidents in 24 hr**
- **Weak winds (<20kt)**



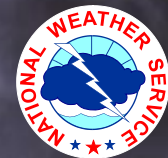
Courtesy: Daily Mining Gazette



2007 Dec 4-5



- Incidents
- Snowfall (in)
- SLR
- Peak Wind (mph)



What these results have allowed us to do...

- Refine our advisory/warning criteria:
 - *8 inches for LES ($\geq 20:1$ SLR)*
 - *6 inches for system snow ($< 20:1$ SLR)*
 - *We also give more forecaster discretion for “windier” events and/or issuing statements for critical time of day (commute times) or special events.*
- Not place as dire impacts in our “standard” LES situations
- Focus more on the sub-advisory, high impact situations
 - *Issue non-traditional statements for these events*
- Develop new Decision Support type products based on impacts...

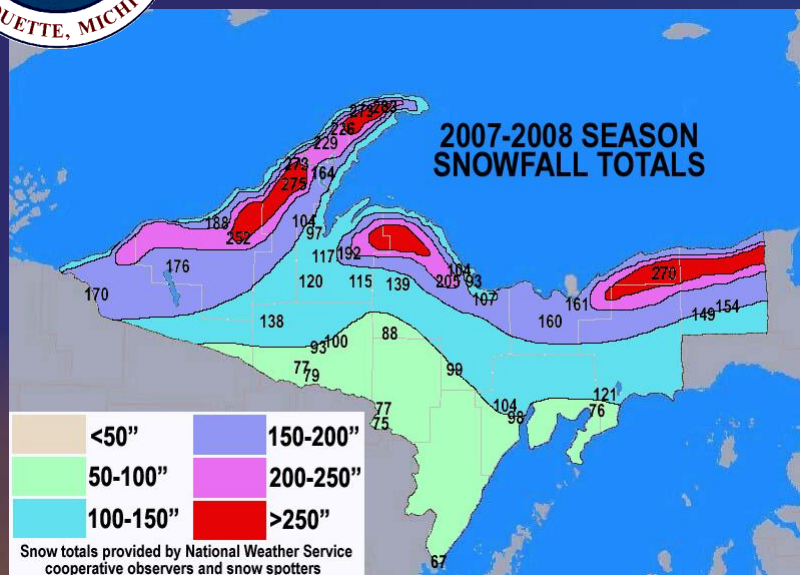


Decision Support Activities for Winter Weather at NWS MQT





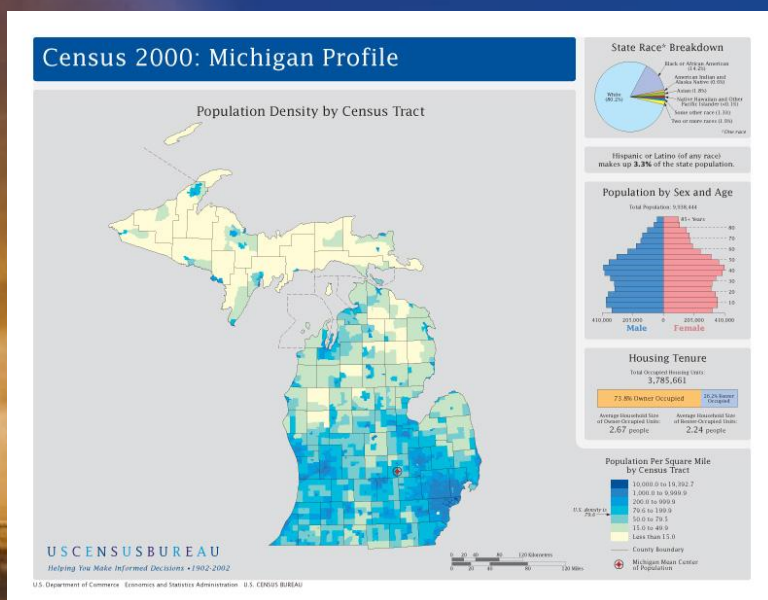
Why?



- Some places in Upper Michigan see over 250 inches of snow each year

— Amounts vary greatly from close to Lake Superior to well inland.

- Although the population of Upper Michigan is small (only +/- 500,000 people), impacts from snow can still be significant (even with amounts less than our traditional warning criteria).





Primary Users of our Winter Forecasts



- **Public**
- **Transportation Sector (i.e. MICHIGAN, County Road Commissions)**
- **Schools**
- **Emergency Managers**



Our goal with Winter DSS

- To provide the best information for decision making using technology by leveraging our digital forecast database.
- We also want to give our customers detail on exactly where the worst conditions will occur
- For high impact events, we also use more traditional type of DSS including:
 - *Conference Calls*
 - *Webinars*
 - *Phone-Phone contacts*



Winter Hazards Page

- This page allows us to package all of the winter hazards into a temporal series of images (6 hourly)
- It allows our users to quickly see what winter hazards will affect them without having to sort through a long forecast
- Differentiates between “types” of snow as well as the main hazards based on our winter impact experiment

"City, St" or Zip Code

City, St Go

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Upper Michigan Winter Hazards

Last Updated: Sun Feb 10 12:25:02 GMT 2013.

[This Morning](#)
[This Aftn](#)
[This Evening](#)
[Early Mon AM](#)
[Mon Morning](#)
[Mon Aftn](#)
[Mon Evening](#)
[Early Tue AM](#)

6 hrs ending 01 AM Feb 11, 2013

Heavy Snow is more than 3" inches of snow (4" Lake Effect). **Moderate Snow** is more than 1.5 inches of snow.

| | | |
|-------------------------|----------------------------|--------------|
| Heavy Snow | Moderate Snow | Blowing Snow |
| Heavy Snow/Blowing Snow | Moderate Snow/Blowing Snow | |

Heavy Ice is more than 0.12" ice accumulation. **Moderate Ice** is more than 0.04" ice accumulation

| | | |
|-------------------------|----------------------------|--|
| Heavy Ice | Moderate Ice | |
| Heavy Ice/Heavy Snow | Moderate Ice/Heavy Snow | |
| Heavy Ice/Moderate Snow | Moderate Ice/Moderate Snow | |

| | | |
|-----------------------|-----------------------------|-----------------------|
| Hvy Snow/Hvy Ice/BLSN | Hvy Snow/Mod Ice/BLSN | Hvy Ice/Mod Snow/BLSN |
| Mod Ice/Mod Snow/BLSN | No Hazardous Winter Weather | |

Web Site Owner:
National Weather Service
Marquette, MI Weather Forecast Office
112 Airpark Drive South
Negaunee, MI 49866
906-475-5212

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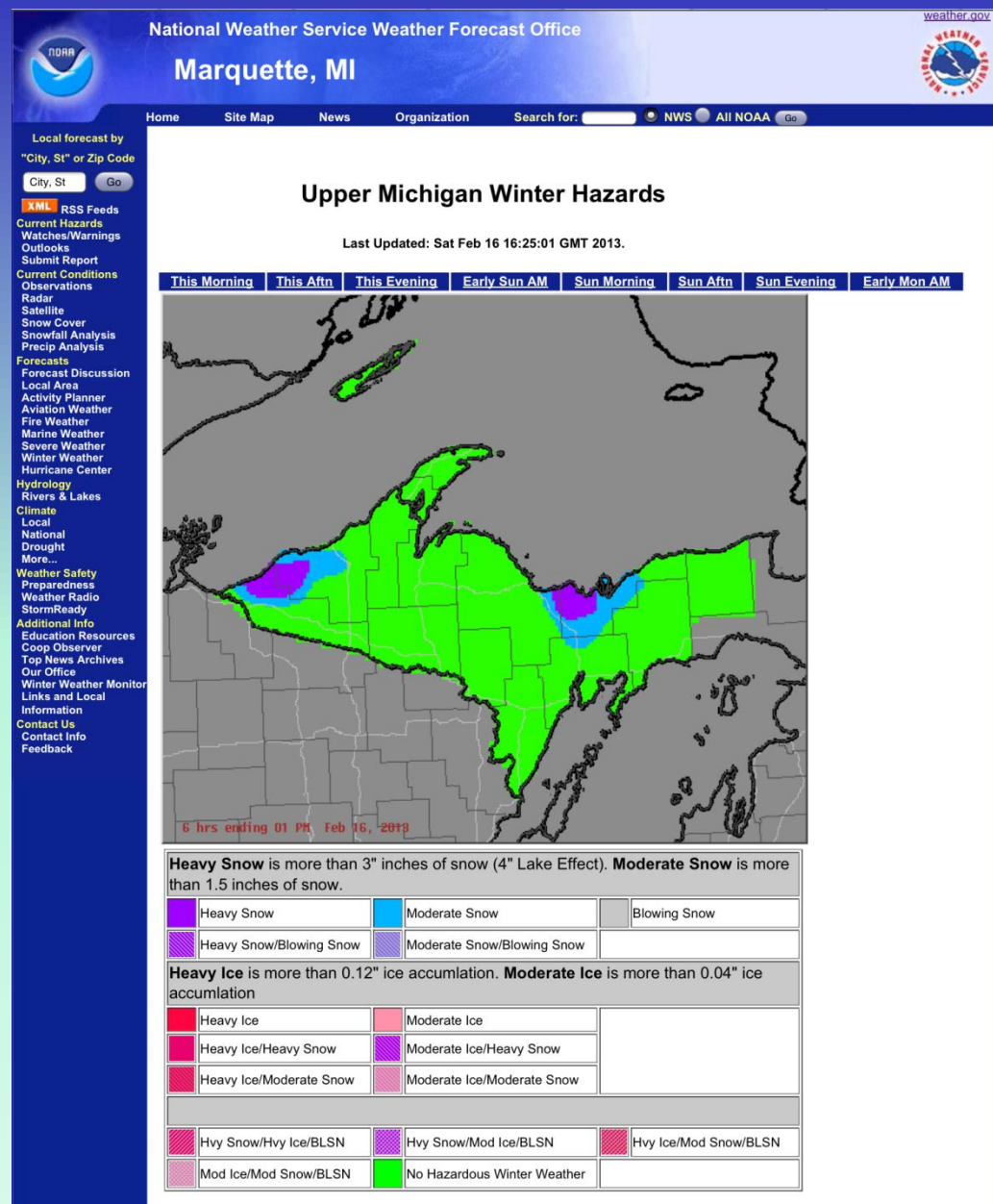
Derived from our Digital Forecast



Winter Hazards Page

Lake Effect Snow Example

Can be very specific regarding where the worst conditions will occur.





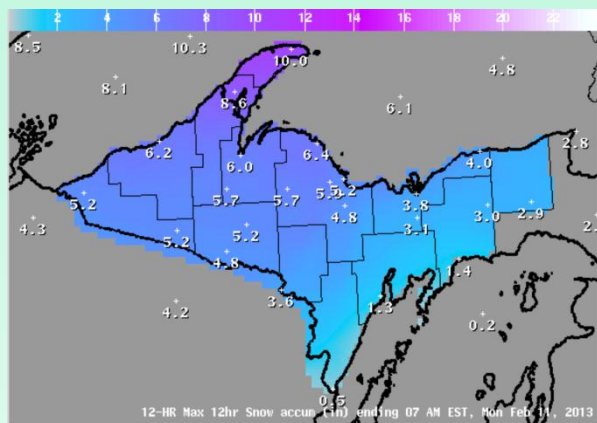
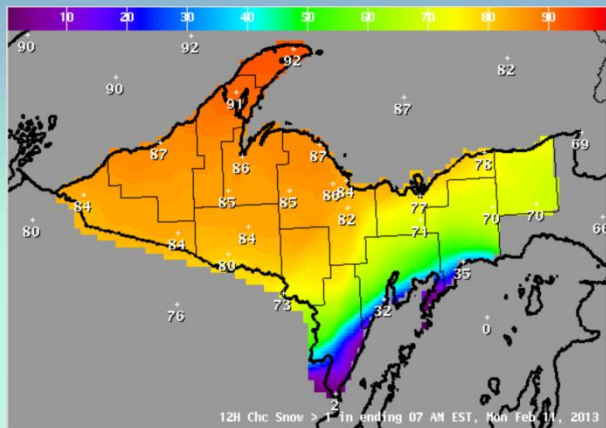
Probabilistic Snowfall

- Based on PQPF work done by Steve Amburn (NWS Tulsa) and PSNOW work by Dr. Greg Mann (NWS Detroit/Pontiac)
- Derived from PoP and Quantitative SnowAmt forecasts
 - *Allows us to give an unconditional probability to exceed specified snowfall amounts*
- Based on the climatological distribution of precipitation, which very closely matches the special gamma distribution called the exponential distribution (results similar to Jorgensen, Klein and Roberts, 1969)
 - *Indicates that the probability of receiving larger rainfall/snowfall amounts decreases exponentially as amounts get larger*
- Allows us to quickly give customers our confidence on critical snowfall thresholds as well as our likely range of values

See http://www.crh.noaa.gov/mqt/?n=pqpf_explain for more details



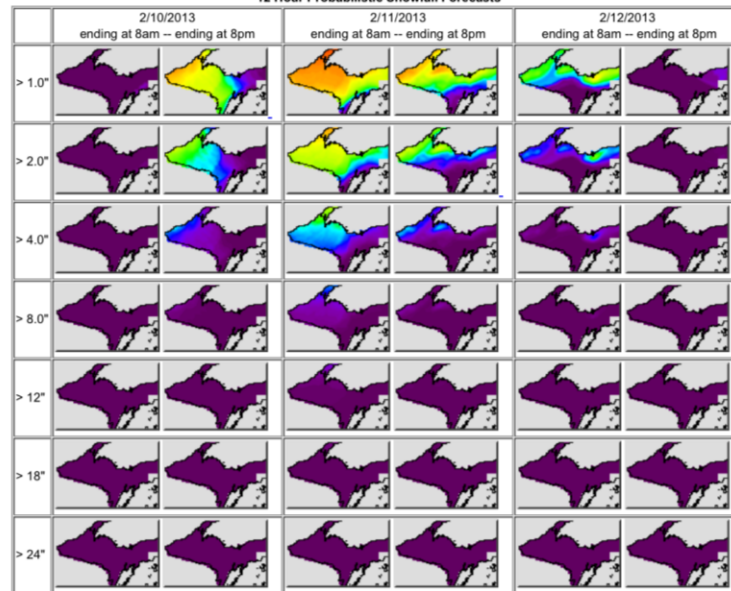
Probabilistic Snowfall



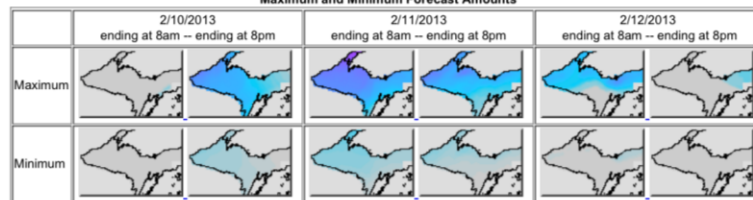
Experimental Probabilistic Snowfall Forecast for the Upper Peninsula

Probabilistic quantitative precipitation forecasts (PQPF) and quantitative snowfall (PSnow) provide our best estimate of the chance that any given location will receive an amount of rain/snow that exceeds a certain threshold value. For more information go to http://www.crh.noaa.gov/mqt/?n=pqpf_explain.

12 Hour Probabilistic Snowfall Forecasts



Maximum and Minimum Forecast Amounts



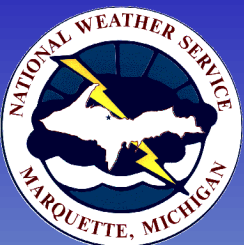
12 Hour Snow Amounts



Click the map for the 12 hour snowfall Forecast for each county



Thanks to NWS Detroit for much of the software



Winter Monitor Page

One stop shop for all of our
winter products

Where we send everyone too
for winter information

Also links to other outside
pages

- Webcams
- DOT Road Conditions
- WPC products

Home Site Map News Organization Search for: NWS All NOAA Go

Local forecast by
"City, St" or Zip Code
 City, St

XML RSS Feeds
Current Hazards
Watches/Warnings
Outlooks
Submit Report
Current Conditions
Observations
Radar
Satellite
Snow Cover
Snowfall Analysis
Precip Analysis
Forecasts
Forecast Discussion
Local Area
Activity Planner
Aviation Weather
Fire Weather
Marine Weather
Severe Weather
Winter Weather
Hurricane Center
Hydrology
Rivers & Lakes
Climate
Local
National
Drought
More...
Weather Safety
Preparedness
Weather Radio
StormReady
Additional Info
Education Resources
Coop Observer
Top News Archives
Our Office
Winter Weather Monitor
Links and Local
Information
Contact Us
Feedback

Winter Monitor

...HEAVY WET SNOW AND MIXED PRECIPITATION DEVELOPING THIS AFTERNOON AND CONTINUING THROUGH MONDAY...

...LOW PRESSURE OVER SOUTHERN NEBRASKA THIS MORNING WILL TRACK NORTHEAST AND MOVE ACROSS THE UPPER GREAT LAKES MONDAY. WET...HEAVY SNOW ASSOCIATED WITH THIS LOW WILL OVERSPREAD UPPER MICHIGAN THIS AFTERNOON AND EVENING. ACROSS PORTIONS OF CENTRAL UPPER MICHIGAN...THE SNOW WILL MIX WITH SLEET...FREEZING RAIN AND RAIN. EXPECT THE MOST PERSISTENT...HEAVIEST SNOW ACROSS THE NORTHWEST HALF OF UPPER MICHIGAN INTO THE DAY ON MONDAY. EVEN AFTER THE LOW PRESSURE SYSTEM MOVES AWAY FROM THE AREA MONDAY AFTERNOON AND THE SNOW DIMINISHES OVER THE INTERIOR NEAR THE WISCONSIN BORDER...THERE WILL BE LINGERING LAKE EFFECT SNOW NEAR LAKE SUPERIOR.

Click on the map below for the latest forecast.

[Read watches, warnings & advisories](#) [Zoom Out](#)
[SEND US your snowfall/precipitation reports.](#)

NEW: 6 hourly Winter Hazards Graphics

| Latest Forecasts | Observations/Snowfall | Discussions |
|---|--|--|
| <ul style="list-style-type: none">Watches/Warnings/AdvisoriesSpecial Weather StatementsMarine Headlines | <ul style="list-style-type: none">Recent COOP ReportsHourly Weather RoundupLocal Storm Reports | <ul style="list-style-type: none">Hazardous Weather OutlookArea Forecast DiscussionHeavy Snow Discussion |

| Decision Support | | |
|--|---|---|
| 12 Hr Probabilistic Quantitative Snowfall Forecast | 12 Hr Probabilistic Quantitative Precipitation Forecast | 24 Hr Observed Snowfall |

[Precipitation Type Probabilities by County](#)

| Forecast Conditions for the Upper Peninsula | Forecast Temperatures for the Upper Peninsula |
|--|--|
| The graphics below are for expected weather conditions for Upper Michigan. Clicking on an image will | The graphics below are "snap shots" of expected highs, lows, and |

Current **Outlooks**

[Local Radar](#) [Snow Day 1 > 4"](#)

[Regional Radar](#) [Snow Day 2 > 4"](#)

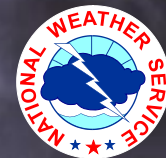
[Weather Story](#) [Snow Day 3 > 4"](#)

[Satellite](#) [Ice Accumulation Day 1](#)

[Weather Map](#) [Ice Accumulation Day 2](#)



Enhanced Hazardous Weather Outlook (EHWO)

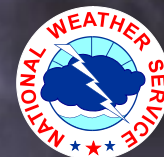


- A graphical way to look at a complete suite of weather and water hazards across Upper Michigan (including winter hazards)
- Developed by NWS Springfield Missouri.
- Totally derived from our gridded forecast database (although manual intervention is also necessary at times)
- Daily resolution out to 7 days

| ***Experimental*** | | | | | | | | | | | |
|--|----------|----------------|--------------|---------------|-------------------------------------|------------|------------|------------|------------|-----------|-----------|
| Enhanced Hazardous Weather Outlook - Maximum Risk for Each Day (click link or hazard icon to enter site) | | | | | | | | | | | |
| Today/Tonight | | | | | Max. Risk Days 2 to 7 (All Hazards) | | | | | | |
| Severe Thunderstorms | Flooding | Winter Weather | Fire Weather | Other Hazards | | Sat Apr 27 | Sun Apr 28 | Mon Apr 29 | Tue Apr 30 | Wed May 1 | Thu May 2 |
| | | | | | Land | | | | | | |
| | | | | | Marine | | | | | | |



Example EHWO for LES



[Product Survey](#)

National Weather Service - Marquette, MI -
Experimental Enhanced Hazardous Weather Outlook (EHWO)

[Product Description Document](#)

The **Experimental Enhanced Hazardous Weather Outlook** is an experimental product that will be posted to this page for evaluation. We encourage your comments or suggestions for improvements using the [electronic survey](#) provided. Your feedback will help us determine product utility, if modifications are needed, and whether the product should become part of our operational suite.

The **Experimental Enhanced Hazardous Weather Outlook** is a decision support service that supports preparedness and response efforts prior to and during hazardous weather. This service provides decision makers with convenient access to potential weather hazard information by graphically depicting the risk of weather hazards out through seven days.

Product Suite Last Updated: Monday Apr 29, 2013 09:59:41 AM

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Snow and Sleet Risk

Today/Tonight

Tue Apr 30

Wed May 1

Thu May 2

Fri May 3


Sat May 4

Sun May 5

Snow/Sleet Forecast (6 hourly)

[\[0-6\]](#) [\[6-12\]](#) [\[12-18\]](#) [\[18-24\]](#) [\[24-30\]](#) [\[30-36\]](#)

[Safety & Education](#)

 **National Weather Service - Marquette, MI**
Snow and Sleet Risk
Today/Tonight

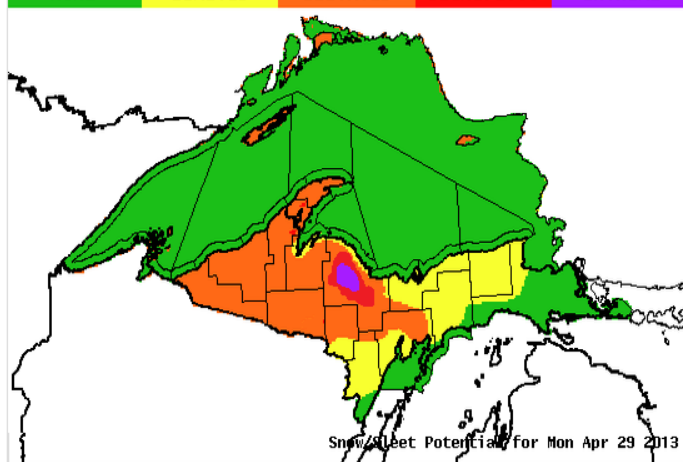
NONE

LIMITED



ELEVATED

SIGNIFI...

EXTREME



Snow/Sleet Potential for Mon Apr 29 2013

 **National Weather Service WFO Marquette MI** 

Risk Level - Legend


None

Limited

Elevated

Significant

Extreme



Note: To display hazard maps, click on any of the risk level indicators below.

Today/Tonight

Risk

Level

Risk

Level

Tornado

Fog

Hail

Non - Thunderstorm Winds

Thunderstorm Wind Gusts

Extreme Heat

Flooding

Snow and Sleet

Lightning

Freezing Rain

Spotter Outlook

Frost and Freeze

Fire Weather

Extreme Cold

Coastal Flooding

Rip Currents

High Surf

Marine Hazard

Freezing Spray

Tuesday April 30 to Sunday May 5

Risk

Tue Apr 30

Wed May 1






Thu May 2

Fri May 3

Sat May 4

Sun May 5

Level

| Risk Level | | Definition |
|--|-------------|---|
|  | None | Little (<1 inch) or No snow or sleet accumulation. |
|  | Limited | Snow and/or sleet expected from "System Snow" to accumulate <u>1 to 2.9 inches</u> AND/OR "Lake Effect Snow" to accumulate <u>1 to 4.9 inches</u> . |
|  | Elevated | Snow and/or sleet expected from "System Snow" to accumulate <u>3 to 5.9 inches</u> AND/OR "Lake Effect Snow" to accumulate <u>5 to 7.9 inches</u> . |
|  | Significant | Snow and/or sleet expected from "System Snow" to accumulate <u>6 to 9.9 inches</u> AND/OR "Lake Effect Snow" to accumulate <u>8 to 11.9 inches</u> . |
|  | Extreme | Snow and/or sleet expected from "System Snow" to accumulate more than <u>10 inches</u> AND/OR "Lake Effect Snow" to accumulate more than <u>12 inches</u> . |



Thank You



Questions?

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